A CLASSIFICATION OF ENERGY SOURCES

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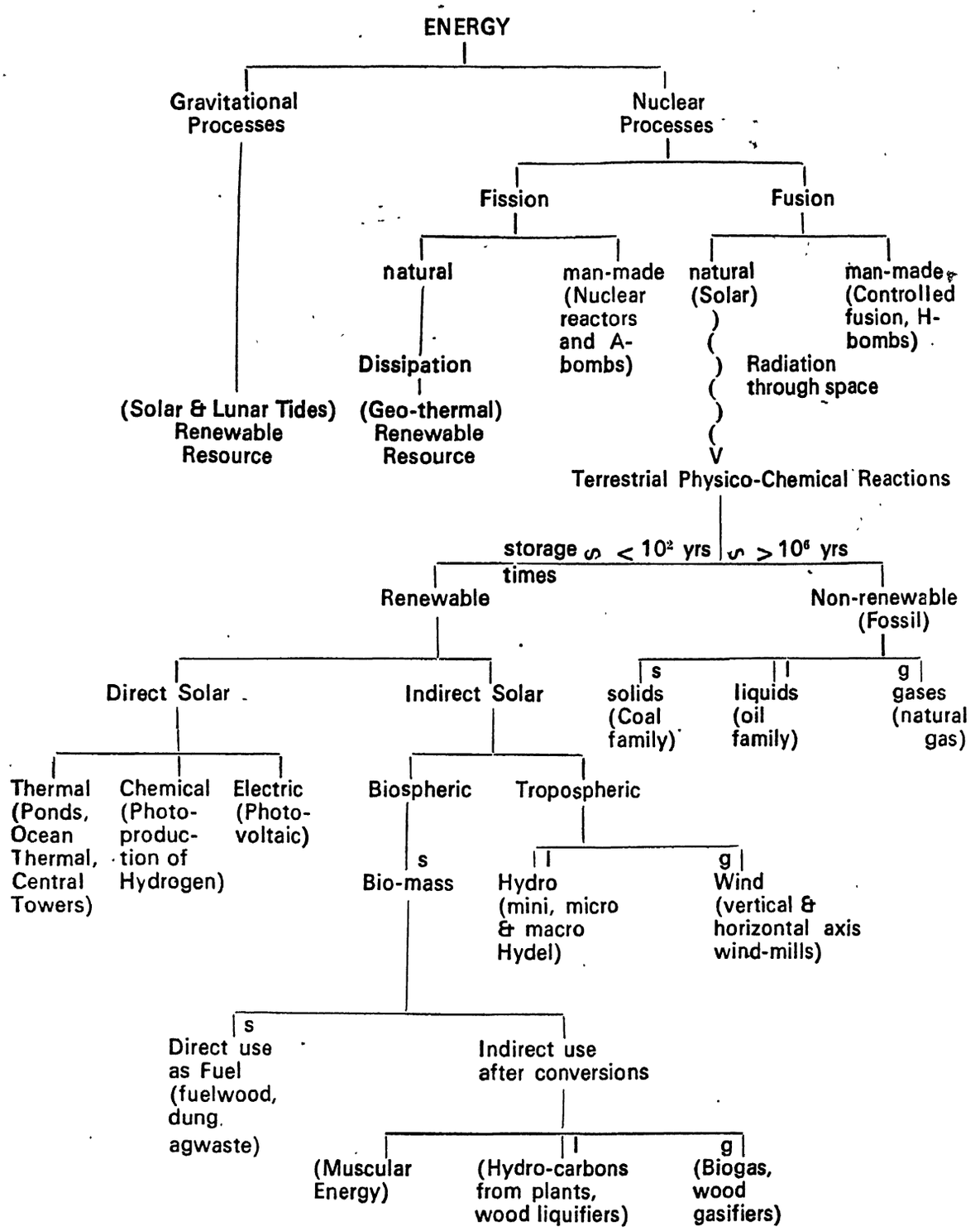
This brief note attempts to clarify the widespread semantic confusion that exists regarding the usage of various terms employed to distinguish between different types of energy sources. One of the reasons for these conceptual difficulties is the plethora of descriptions (for different energy sources), and their negatives, that have found their way into common parlance but which really do not perform a good job of discriminating between the energy sources. These are opposites like conventional and non-conventional, traditional and non-traditional, commercial and non-commercial, renewable and non-renewable, existing and alternate, rural and urban, centralized and distributed, animate and inanimate, appropriate and inappropriate, etc. In statistics gathered in Thailand, for example, charcoal use in urban areas is classified as commercial and in rural areas as non-commercial although charcoal may be an object of commerce even in the countryside. In figure 1 we present a taxanomy of energy sources based on physical principles. Some categories of each source are given in parenthesis in the figures.

All the sources of energy currently available for harnessing can be traced to two fundamental forces in nature - the gravitational and the nuclear. It is nuclear fusion which is the source of solar energy - the driving force for most of the energy consumed on earth, today. We distinguish between renewability or non-renewability of a solar-driven process by energy storage or cycling time involved. For a renewable process this is less than a hundred years (with the upper limit chosen to include some afforestation programmes), and for a non-renewable process, it is greater than a million years. There is such a large gap in between that it is possible to jack-knife energy sources into two categories without overlap. The depletable fuels are, of course, the fossil fuels and are non-renewable precisely because our rate of utilization far exceeds the rate at which they were formed.

The solar renewables are subdivided into Direct and Indirect Solar. Sunlight used directly can produce electricity, heat, or drive a chemical reaction. It is used indirectly when it drives other processes, biological-chemical or climatic-mechanical, which in turn are used as sources of energy.

All energy forms are interconvertible, and this interconvertibility has not been shown in the figure to keep it simple. For example, one could use photo-electricity to drive a chemical reaction, wind energy to pump and store water that could be used to produce electricity, when required, or solid biomass to produce liquid or gaseous fuels of higher calorific value.

FIGURE I: A TAXONOMY OF ENERGY SOURCES (STOCKS AND FLOWS)



Another point to be borne in mind is that the classification presented here is not regarding energy forms. It is possible to obtain electricity from the renewable photovoltaics and hydroelectrics, or from the non-renewable fossil fuels. Similarly, liquid hydrocarbons can be extracted from renewable biomass or non-renewable fossil fuels, and so on.

The descriptions that are functions of time (or era), space and scale are unsuited for making a generalised classification of energy sources. These would include conventional, traditional, alternate and their antonyms. Thus wind energy was once traditional in Holland but now is often classified as non-conventional, and nuclear power which some might call conventional in France (because of scale or market share) would be non-conventional in Sri Lanka. Without a spatial and temporal context, the use of such terms ought to be eschewed.

The distinction between appropriate or inappropriate technologies needs some elaboration. One must realise that the appropriateness of a technology largely depends on the method of its introduction in a particular socio-cultural milieu. Acceptance or rejection of the newly introduced technology is most often determined by the anthropological meanings attached to it by the target population, and their reactions to its impact on their social inter-relations*. For a given socio-cultural context, the appropriateness (or otherwise) of a given technology depends on how the population is introduced to the technology, whether there is an effective follow up, and how benefits resulting from the installed technology are distributed. In the People's Republic of China, for example, 30-40% of the six million biogas plants have become dysfunctional mainly because of the failure to impart the necessary technical operating and maintenance skills to farmers. Unfortunately, in most current usage "inappropriateness" condemns, post-hoc, a particular technology rather than the particular methods used for its diffusion. Also, very frequently submerged in such pronouncements are a number of hidden assumptions about desirable directions and rates of progress, the scales of technology etc. that make these labels highly subjective.

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* For an excellent treatment of these issues, see "Advanced Technology and So-called Backwardness : A Solar Pump in a Tribal Indian Village" by Pierre Amado and Dennis Blemont, July, 1983. Reprints available from Prof. Amado, the ASVIN Program, CNRS, Ferrolles, 77330, Ozoir-la-Ferriere, FRANCE.

The division of energy sources into commercial and non-commercial is orthogonal to what we have been discussing. The distinction is based on buying, barter and self-use. So any energy source can be commercial or non-commercial depending on whather or not it enters the 'market place'. By the same token, the same energy source can be non-commercial in place A and commercial in place B. It may also become commercial in place A in the future. So there are no non-commercial sources of energy in general - specifying the spatial and temporal context is again necessary.

The classification scheme presented here is based on the First Law of Thermodynamics. Other (and important) bases for alternative classification schemes of energy sources exist, such as the Second Law of Thermodynamics, the environmental hazards of developing an energy source, energy pay back period of an energy source at the current level of technologial know-how, total (or annual) maximum energy potential of an energy source, investment needed to extract one unit of energy from a given source etc.

It is also possible to have classifications that are independent of sources, but are a function either of the distributing network (centralised vs.decentralised) or of where the end-use occurs (rural vs. urban). Though useful and convenient in certain descriptions, it must not be forgotten that they say nothing about sources.

We have attempted to clarify these concepts because of the conviction that woolly thinking leads to woolly recommendations. The authors welcome any criticism or suggestions to improve this typology.